Preliminary Evaluation of the Potential Impacts of Climate Change in California

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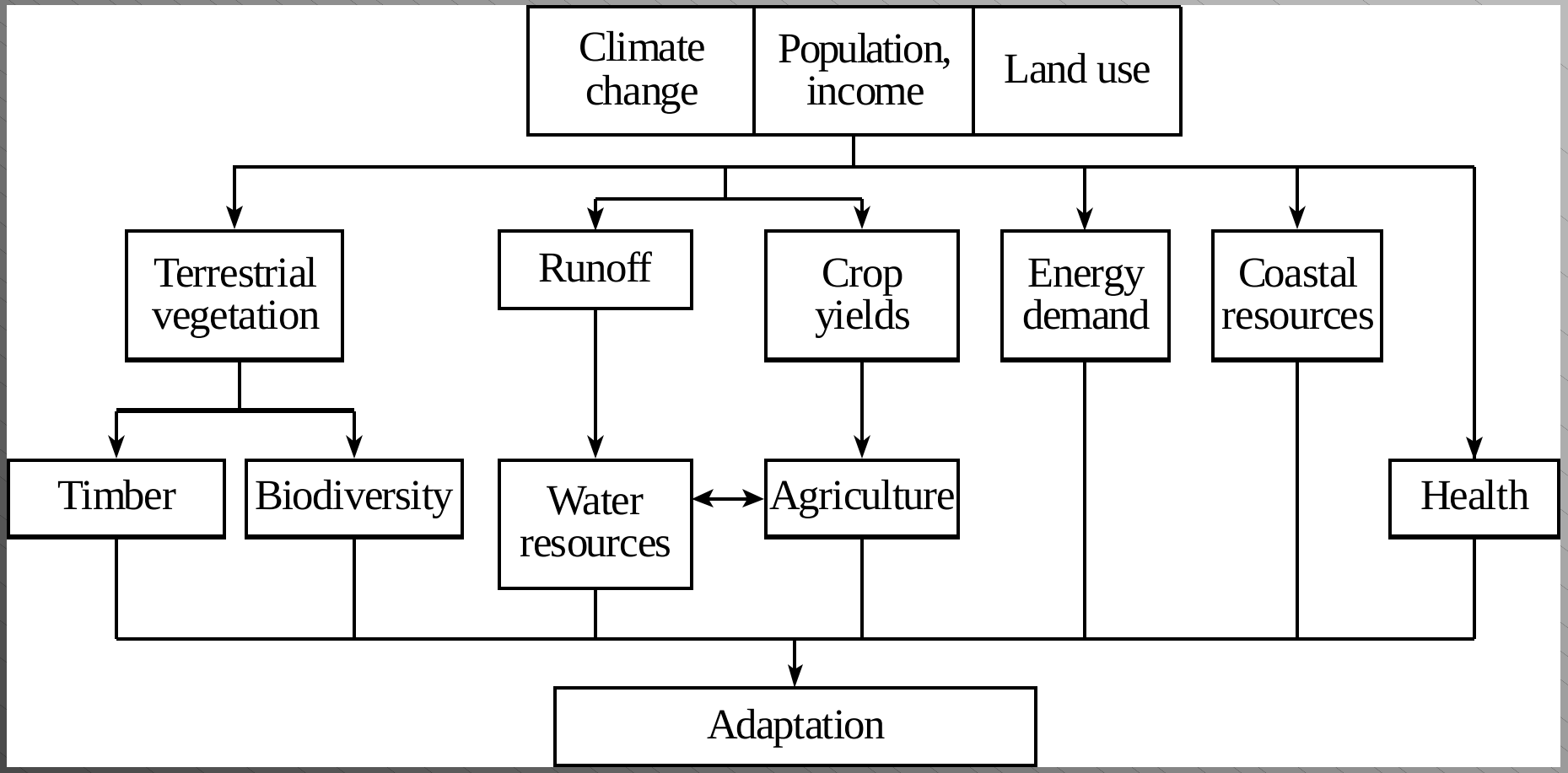
Background

- Primarily funded by California Energy Commission's (CEC) Public Interest Energy Research (PIER) program
  - Co-funded by Electric Power Research Institute
- Help better understand potential climate change impacts on California
  - Use results to identify adaptation issues and needs
  - Note that this is PIER's first analysis of this complicated topic
    - Provides a foundation for further research

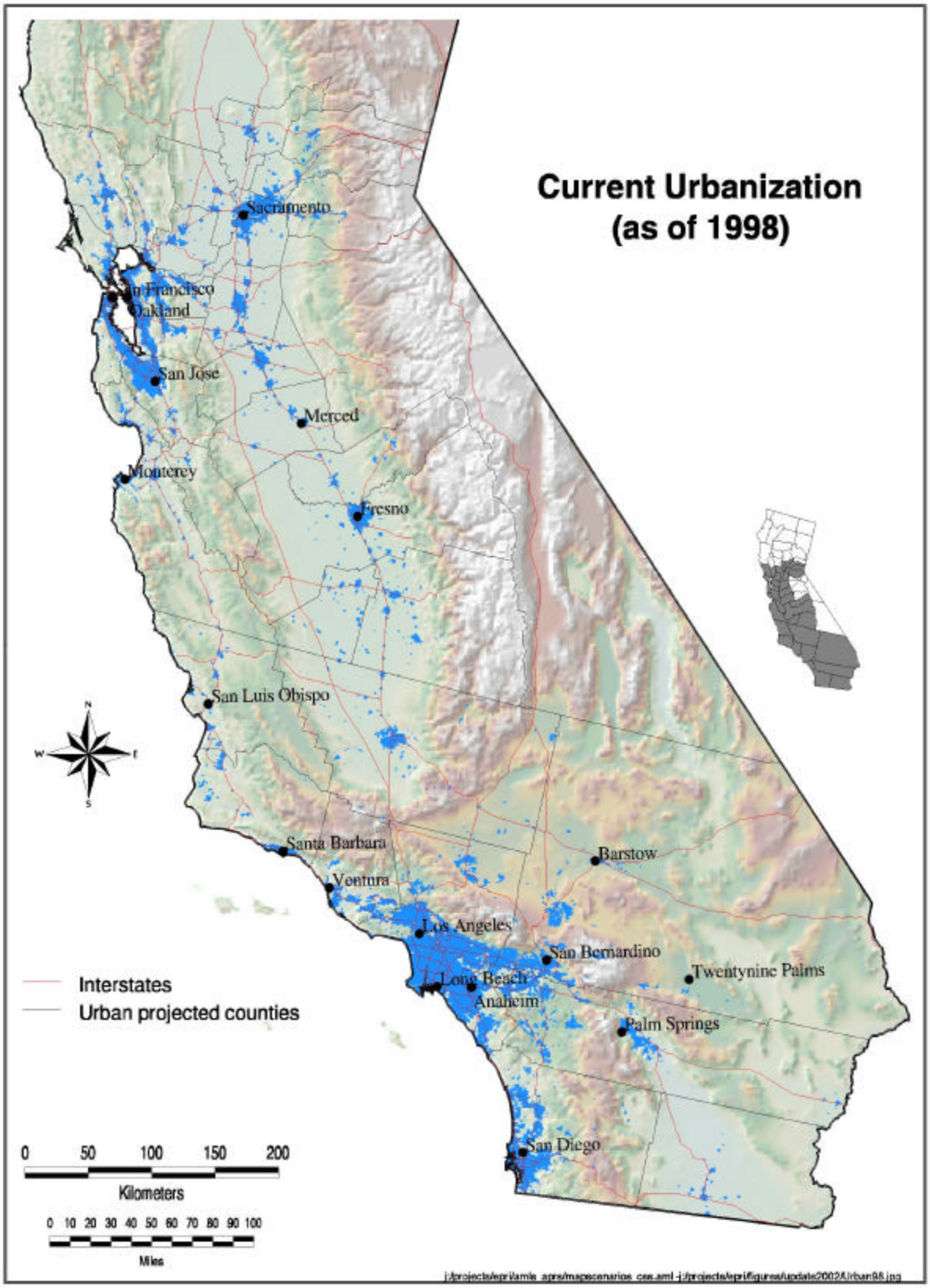
Study Structure

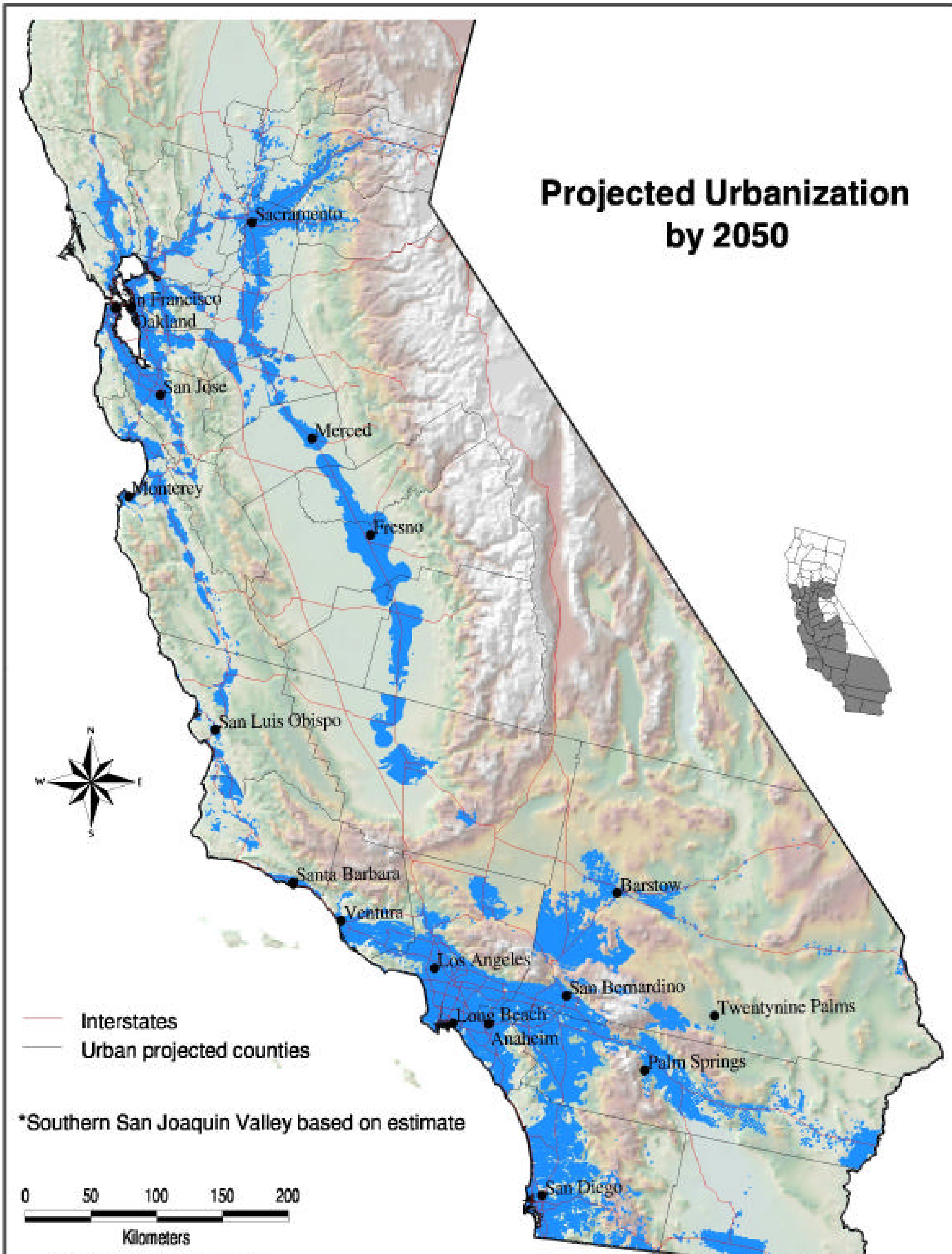


Socioeconomic Scenarios

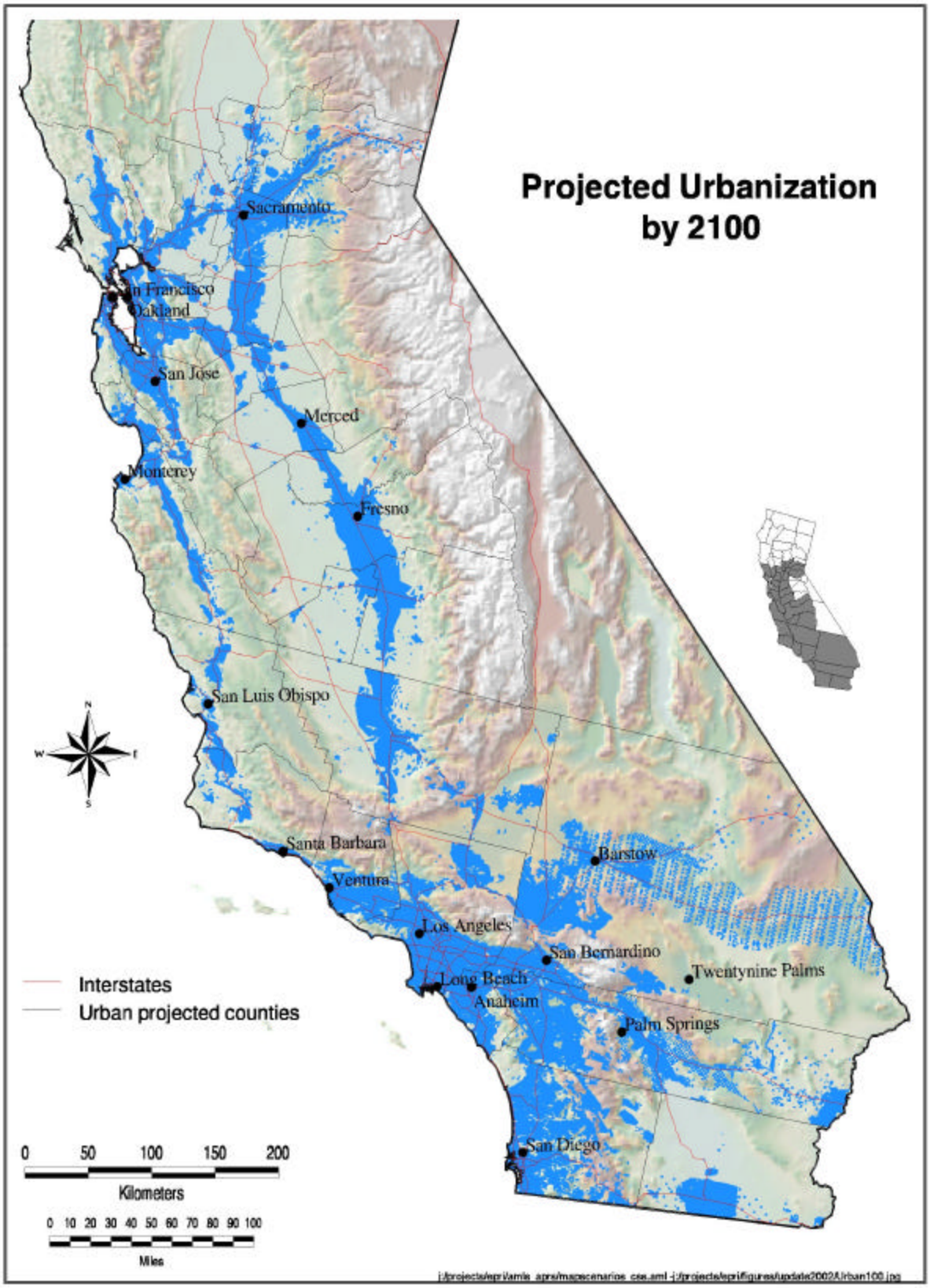
- "Low Population"
  - Population stabilizes at around 60-70 million by latter half of 21st century
  - Per capita income grows 2%/year
- "High Population"
  - Population exceeds 90 million by 2100
  - Per capita income grows 1%/year

A


Current Urbanization
(as of 1998)
Sacramento
San Francisco
Oakland
San Jose
Merced
Monterey
Fresno
San Luis Obispo
Santa Barbara
Ventura
Barstow
Los Angeles
San Bernardino
Twentynine Palms
Long Beach
Anaheim
Palm Springs
San Diego
Interstates
Urban projected counties
0 50 100 150 200
Kilometers
0 10 20 30 40 50 60 70 80 90 100
Miles



Projected Urbanization by 2050
Sacramento
San Francisco
Oakland
San Jose
Merced
Monterey
Fresno
San Luis Obispo
Santa Barbara
Ventura
Barstow
Los Angeles
San Bernardino
Twentynine Palms
Long Beach
Anaheim
Palm Springs
San Diego
N
W
E
S
Interstates
Urban projected counties
*Southern San Joaquin Valley based on estimate
0 50 100 150 200
Kilometers
0 10 20 30 40 50 60 70 80 90 100
Miles


Projected Urbanization
by 2100
Sacramento
San Francisco
Oakland
San Jose
Merced
Monterey
Fresno
San Luis Obispo
Santa Barbara
Ventura
Barstow
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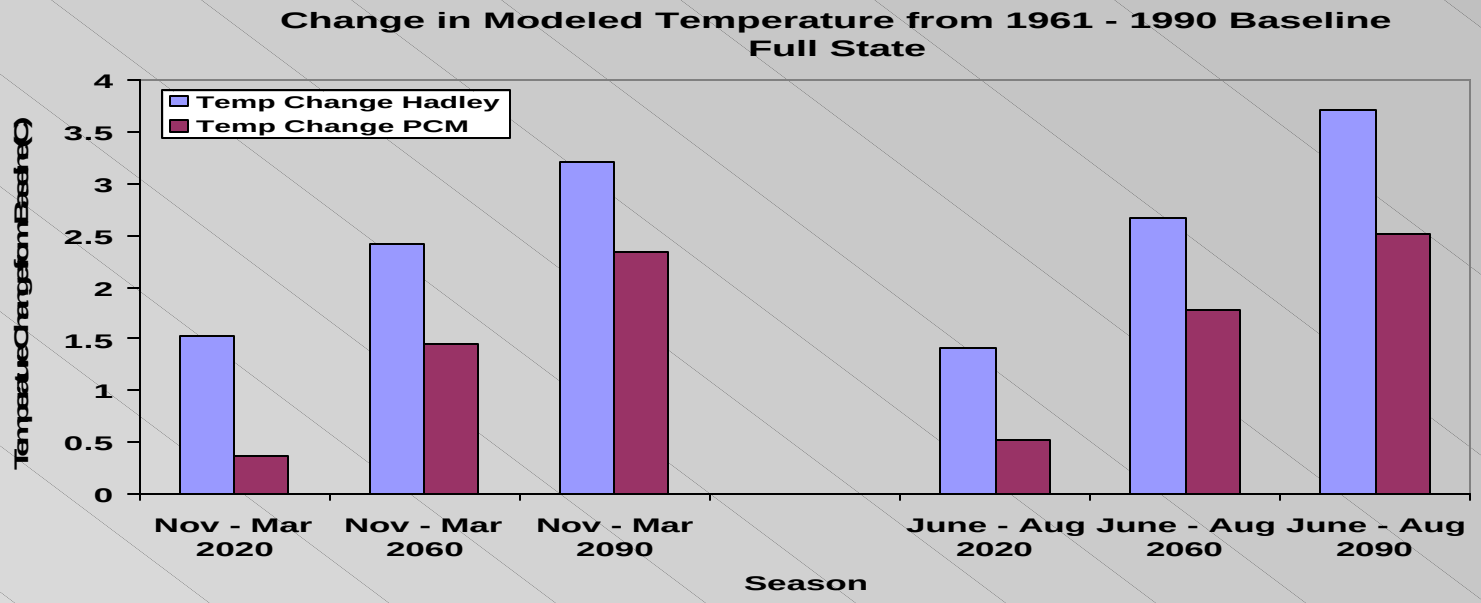
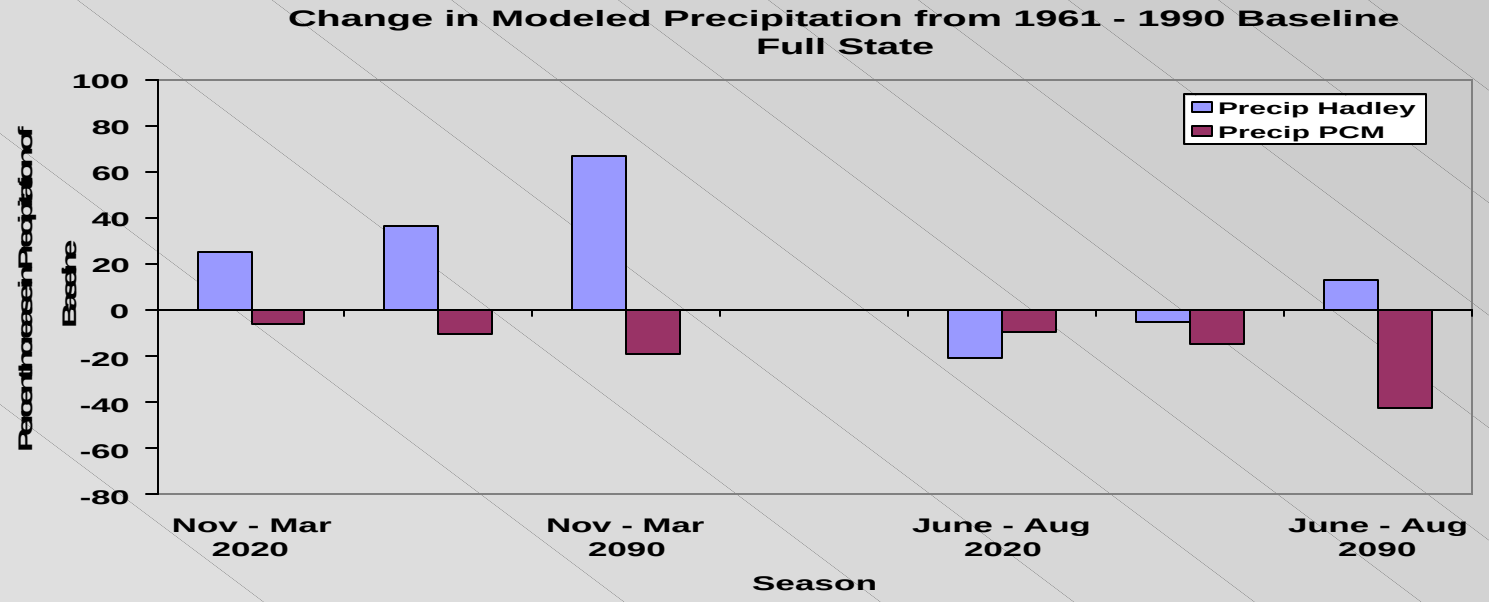
Twentynine Palms
Long Beach
Anaheim
Palm Springs
San Diego
Interstates
Urban projected counties
0 50 100 150 200
Kilometers
0 10 20 30 40 50 60 70 80 90 100
Miles

B


Change in Modeled Temperature from 1961 - 1990 Baseline
Full State
Temp Change Hadley
Temp Change PCM
4
3.5
3
2.5
2
1.5
1
0.5
0
Nov - Mar 2020
Nov - Mar 2060
Nov - Mar 2090
June - Aug 2020
June - Aug 2060
June - Aug 2090
Season


Change in Modeled Precipitation from 1961 - 1990 Baseline
Full State
Precip Hadley
Precip PCM
100
80
60
40
20
0
-20
-40
-60
-80
Nov - Mar 2020
Nov - Mar 2090
June - Aug 2020
June - Aug 2090
Season

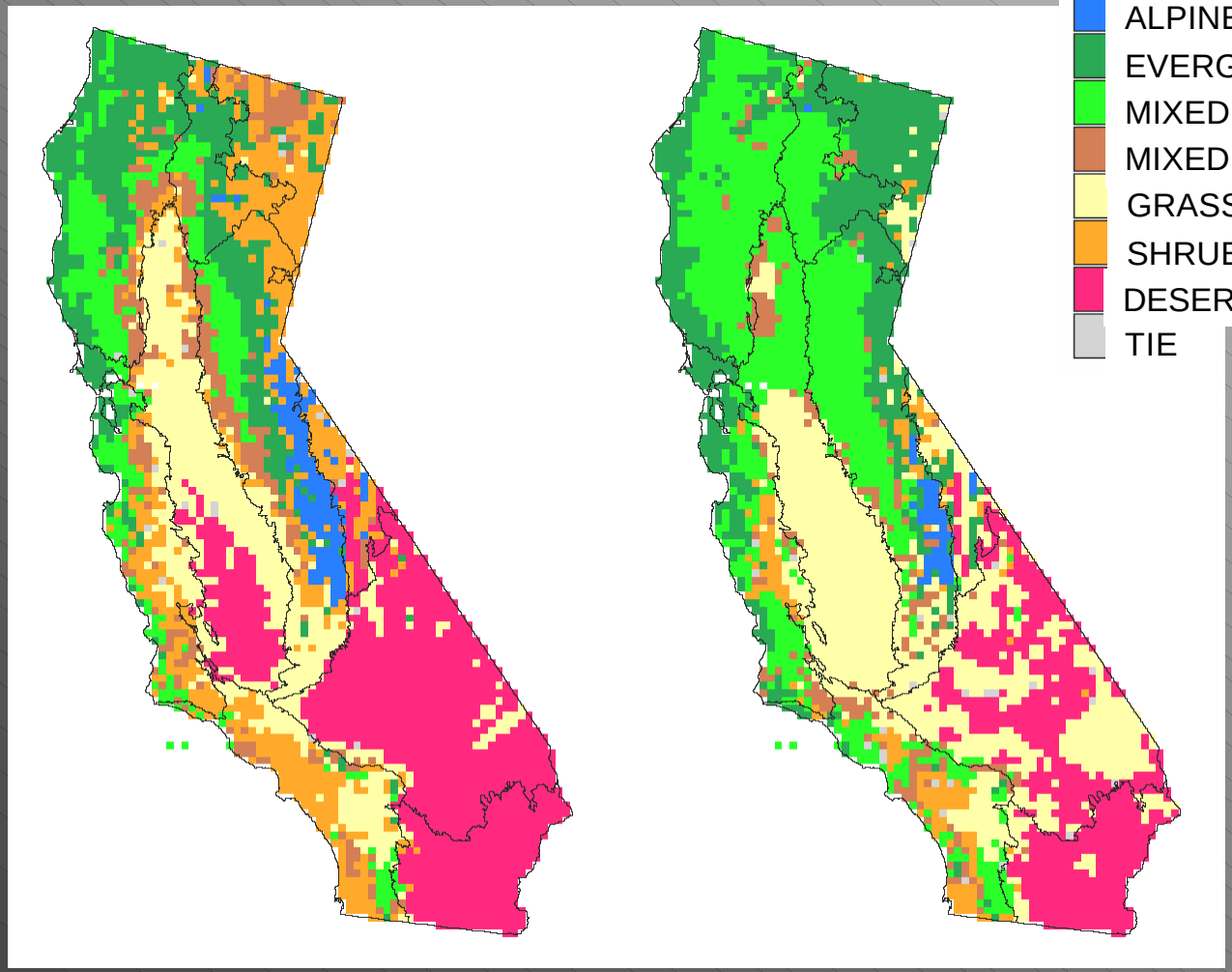
Limitations

- Uncertainties about future socioeconomic conditions
- Did not examine changes in climate variability
- Uncertainties about many biophysical responses
- Uncertainties about adaptation
  - We tended to use optimistic assumptions

Vegetation Analysis

HISTORICAL

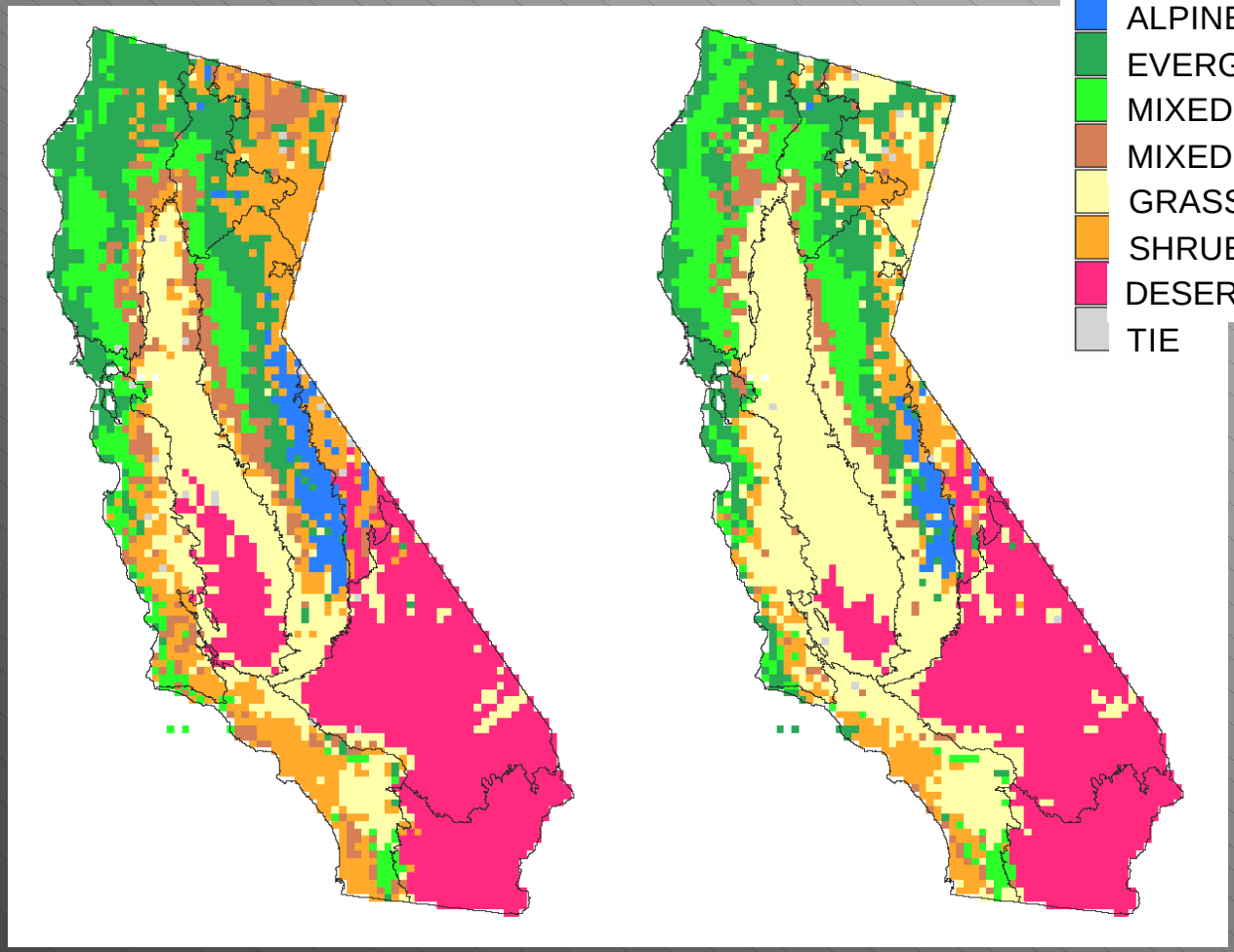
HADLEY



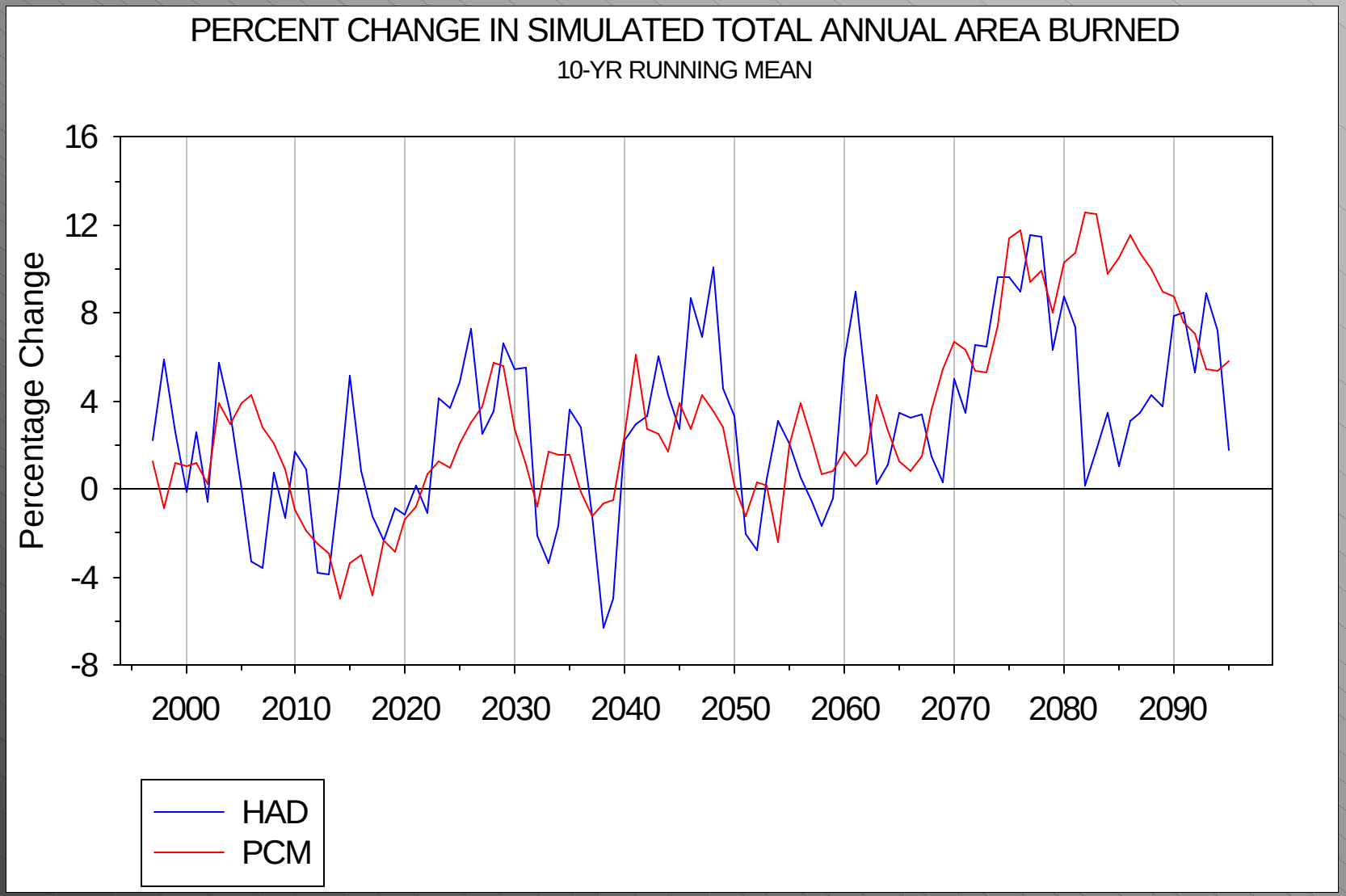
Vegetation Analysis

HISTORICAL

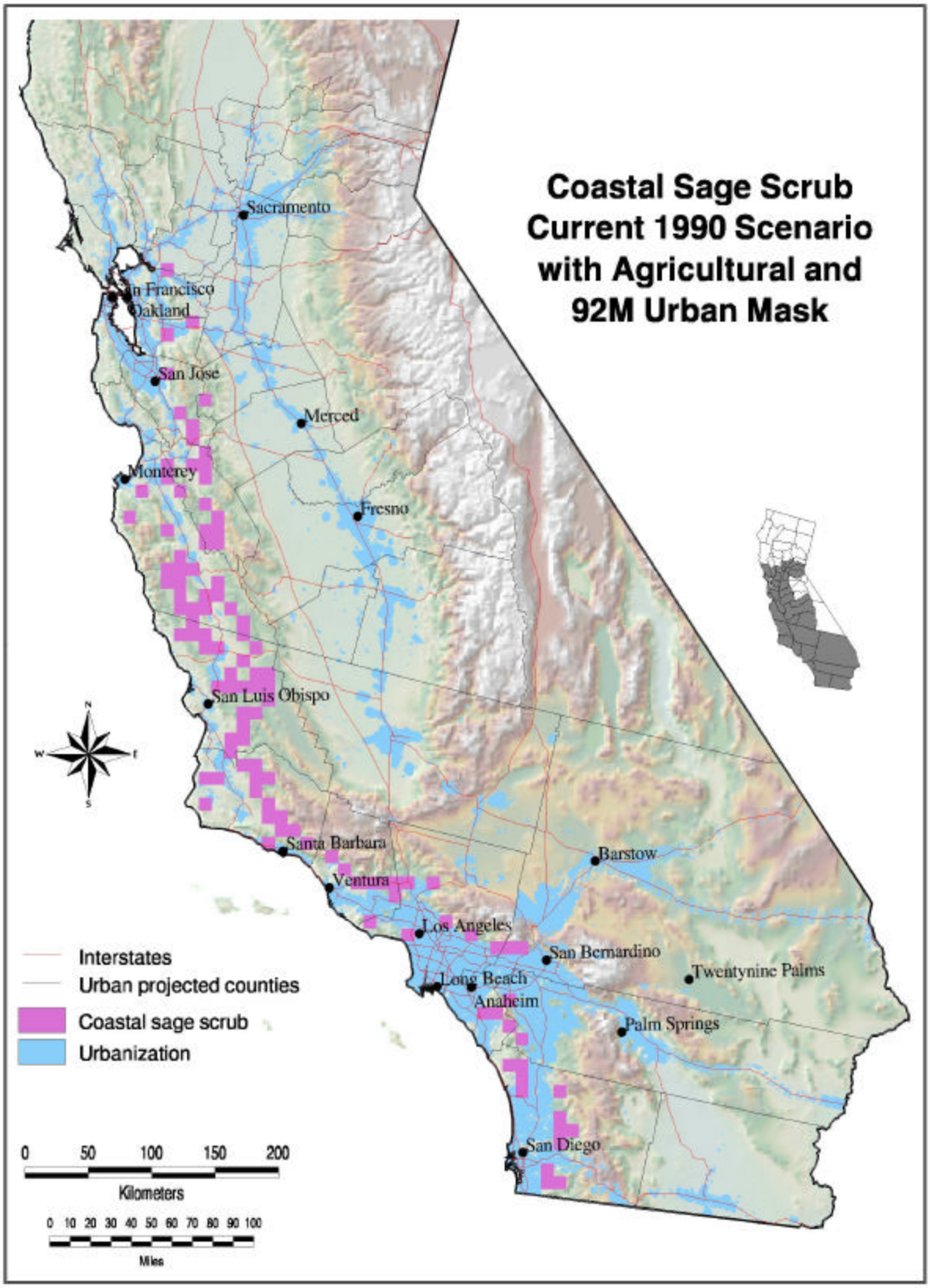
PCM

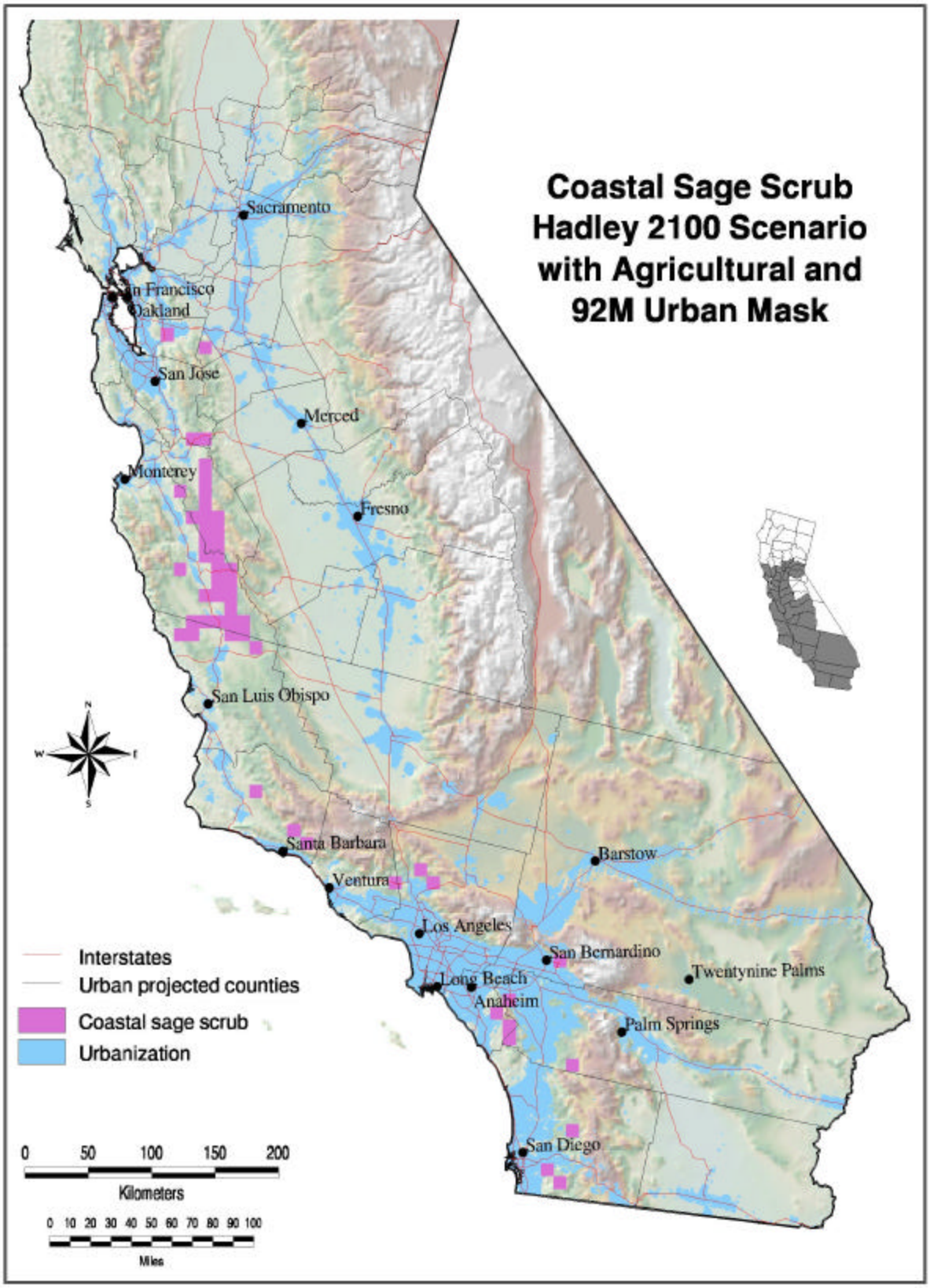


Change in Area Burned



C


Coastal Sage Scrub
Current 1990 Scenario
with Agricultural and
92M Urban Mask
Sacramento
San Francisco
Oakland
San Jose
Merced
Monterey
Fresno
San Luis Obispo
Santa Barbara
Ventura
Barstow
Los Angeles
San Bernardino
Twentynine Palms
Long Beach
Anaheim
Palm Springs
San Diego
Interstates
Urban projected counties
Coastal sage scrub
Urbanization
0 50 100 150 200
Kilometers
0 10 20 30 40 50 60 70 80 90 100
Miles


Coastal Sage Scrub
Hadley 2100 Scenario
with Agricultural and
92M Urban Mask
Sacramento
San Francisco
Oakland
San Jose
Merced
Monterey
Fresno
San Luis Obispo
Santa Barbara
Ventura
Barstow
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Coastal sage scrub
Urbanization
0 50 100 150 200
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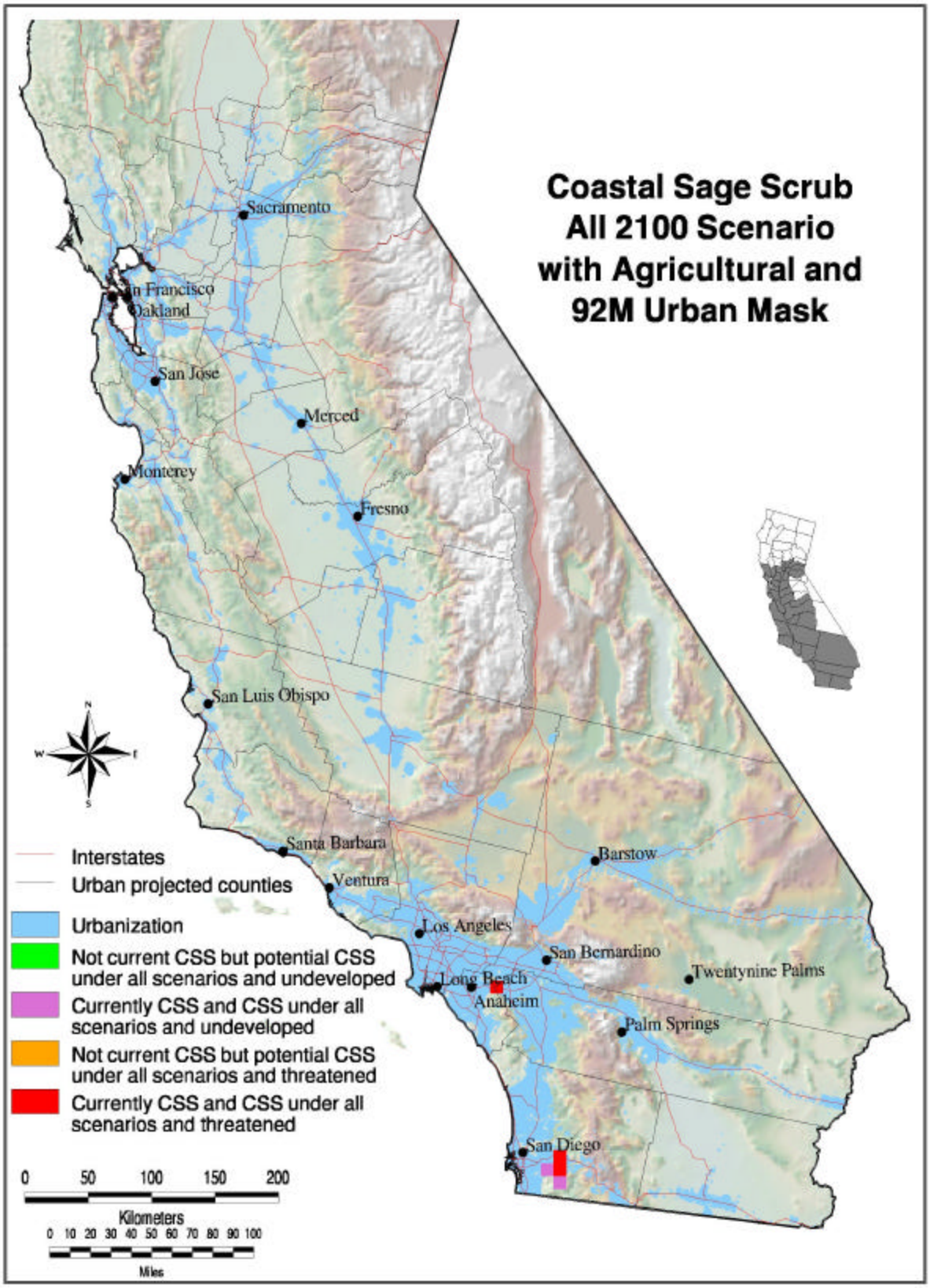
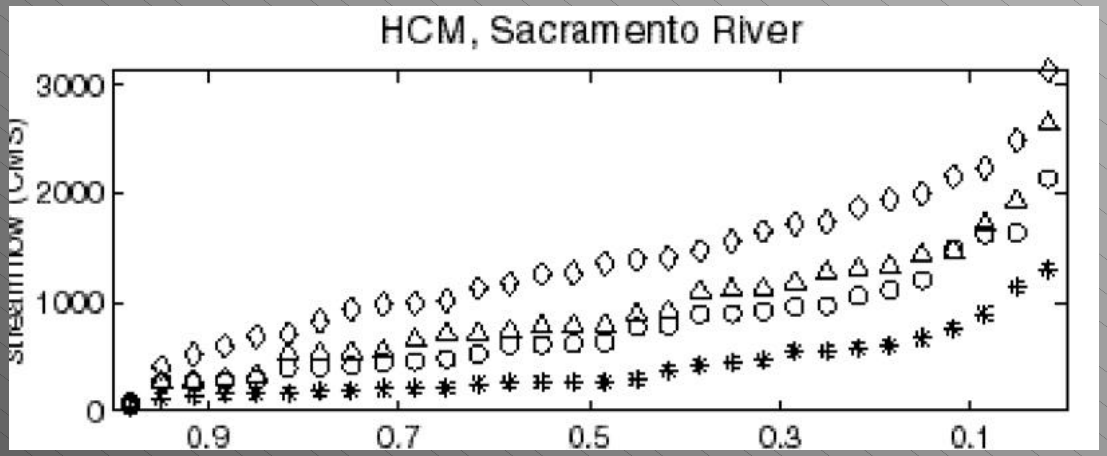

Coastal Sage Scrub
All 2100 Scenario
with Agricultural and
92M Urban Mask
Sacramento
San Francisco
Oakland
San Jose
Merced
Monterey
Fresno
San Luis Obispo
Santa Barbara
Ventura
Barstow
Los Angeles
San Bernardino
Twentynine Palms
Long Beach
Anaheim
Palm Springs
San Diego
Interstates
Urban projected counties
Urbanization
Not current CSS but potential CSS under all scenarios and undeveloped
Currently CSS and CSS under all scenarios and undeveloped
Not current CSS but potential CSS under all scenarios and threatened
Currently CSS and CSS under all scenarios and threatened
0 50 100 150 200
Kilometers
0 10 20 30 40 50 60 70 80 90 100
Miles

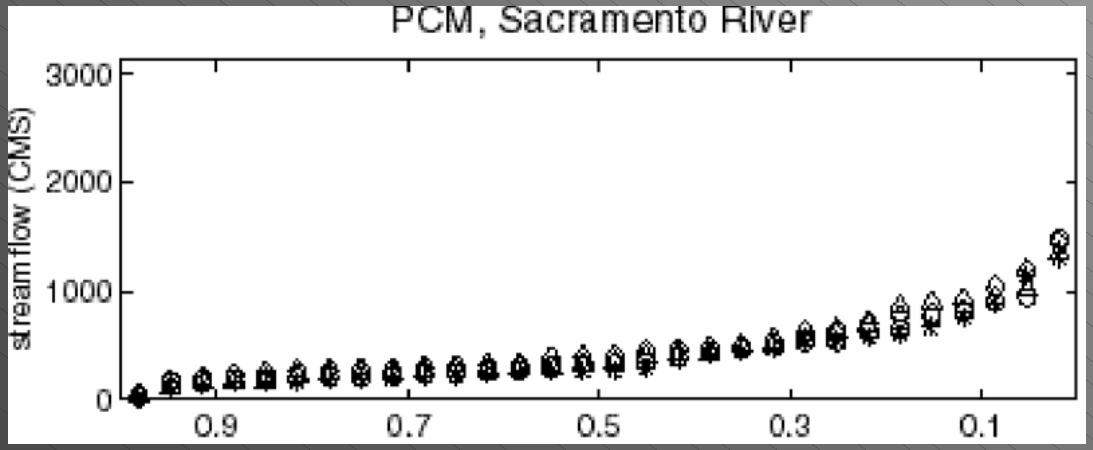
D

Change in Water Availability

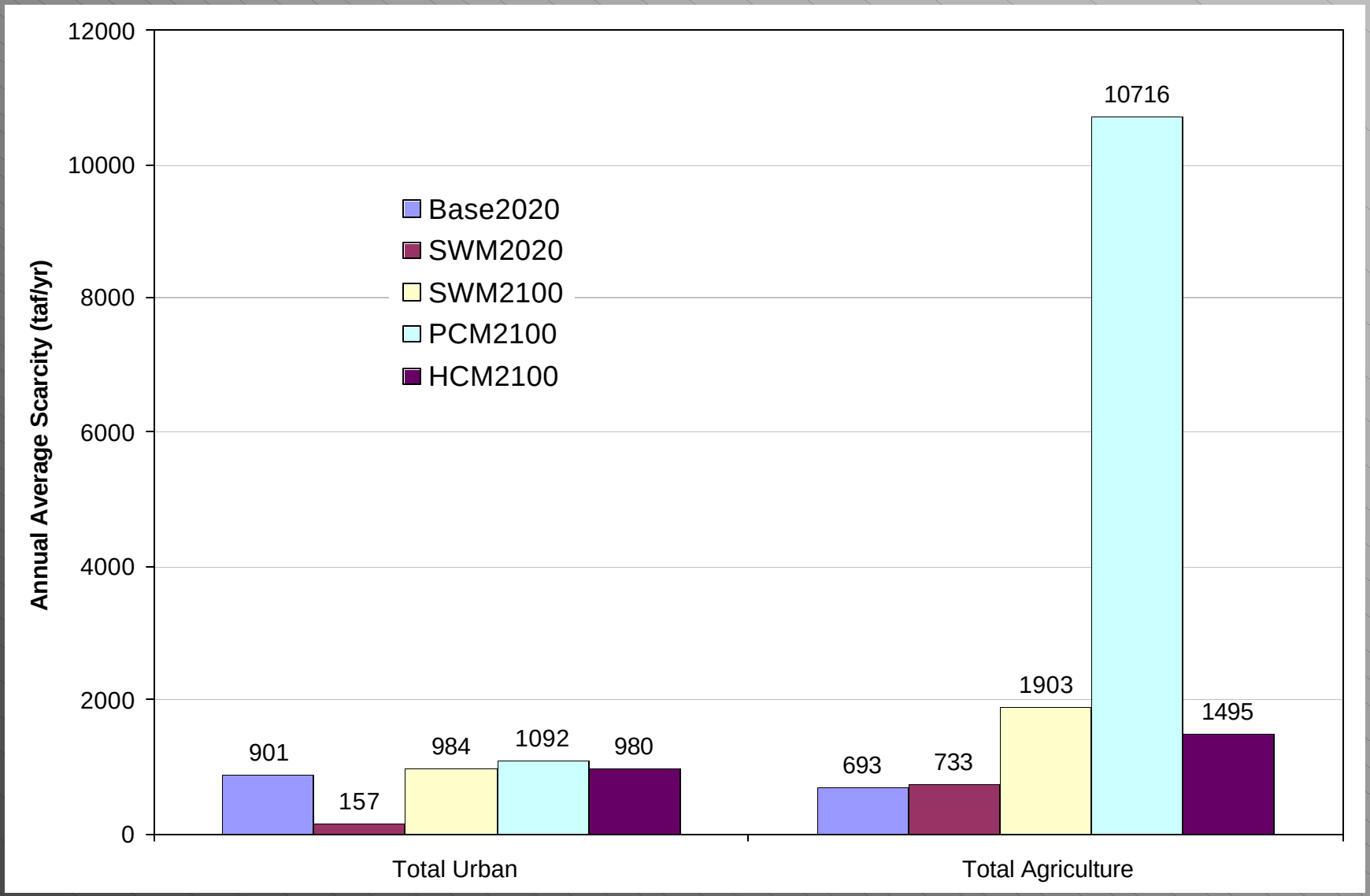
SCENARIO	% CHANGE
HADCM3	+ 12%
PCM	- 25%
+3^{o}C 0 Precip	-11%
+3 ^{o}C + 18% Precip	-2%
+5 ^{o}C 0 Precip	-16%
+5 ^{o}C + 30% Precip	-14%

Change in Flood Exceedence Probabilities for the Sacramento River

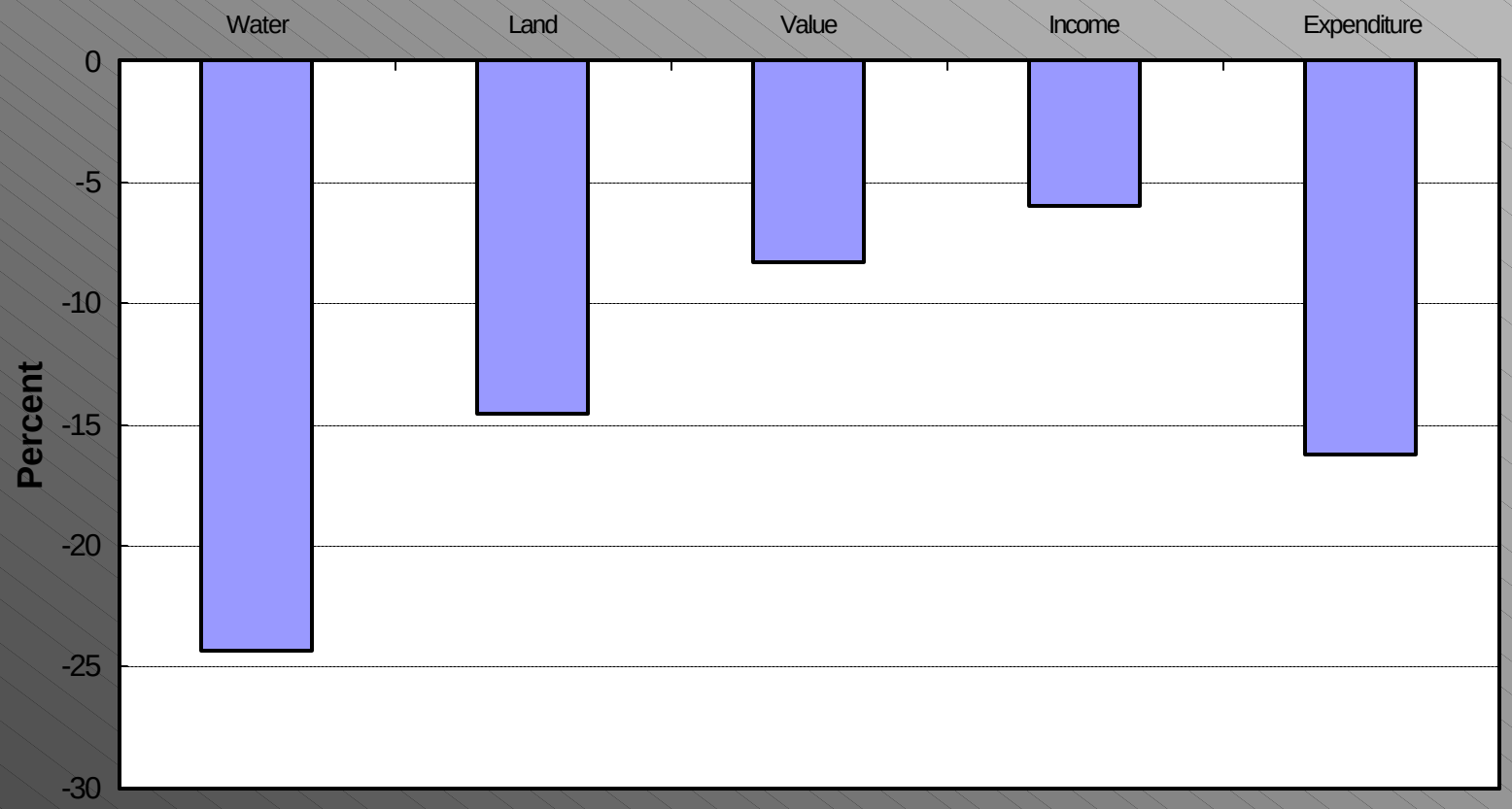




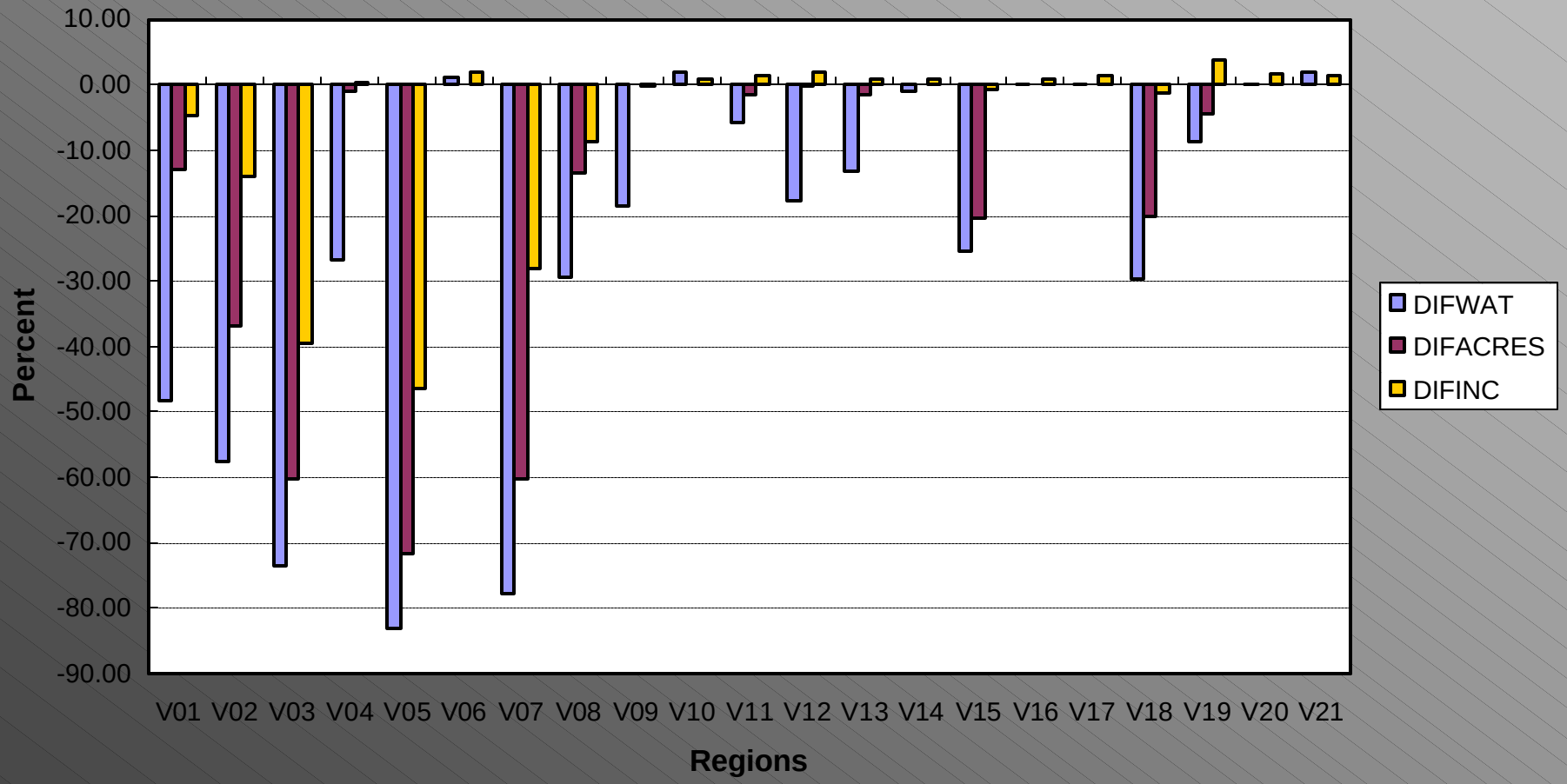
Unmet Demands



Impacts of PCM Scenario on CA Agriculture Production



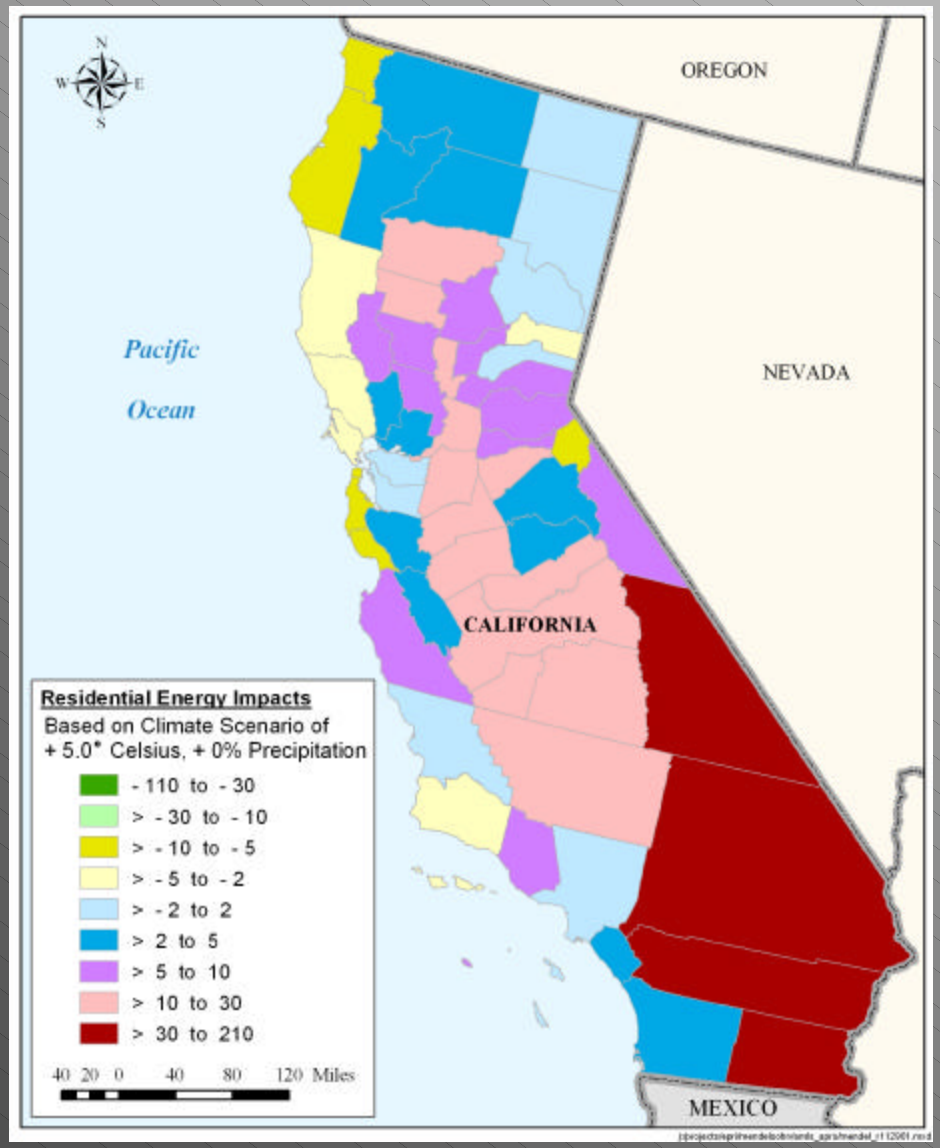
Regional Changes in Agriculture: PCM Scenario



Climate Impacts on CA Energy (billion$/yr)

YEAR	Hadley	PCM
2020	$1.6 – 2.0	$0.2 – 0.4
2060	$4.0 – 5.2	$2.7 – 3.7
2100	$6.2 – 11.6	$4.2 – 6.9

Regional Distribution of Energy Use Impacts for a 5ºC Temperature Rise



Conclusions

- California has a large economy that apparently can adapt to climate change, but at a cost
  - Annual costs could be $ billions/year
  - Energy costs largest item quantified
- Effects more adverse in southern California
  - But agriculture in northern California could face adverse impacts
- Ecosystem impacts likely to be substantial
  - Reduced biodiversity
  - Combined effects with urbanization are more negative

Need for More Research on:

- Effects of changes in climate variability
- Adaptation; more realistic assumptions
- Model improvements, e.g., vegetation, water resources
- Understanding of biodiversity impacts
  - Include aquatic and riparian ecosystems
- Understanding of energy demand
- Understanding of human health impacts
- Understanding of economic impacts of GHG emissions reductions